# PATENT ABSTRACTS OF JAPAN

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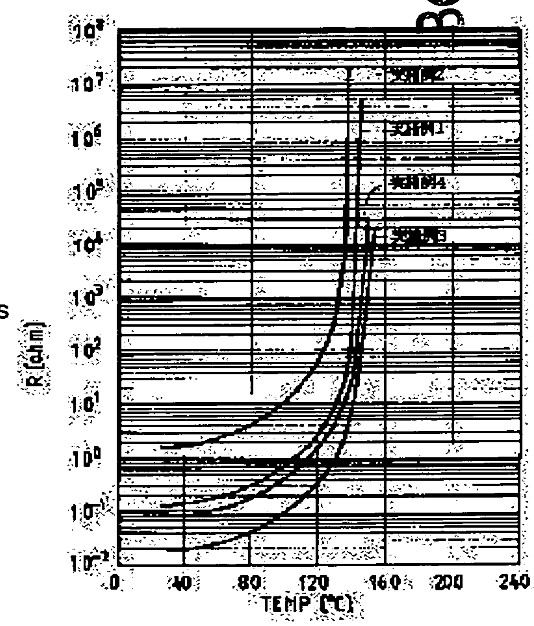
## (54) TEMPERATURE COEFFICIENT ORGANIC POSITIVE CHARACTERISTICS THERMISTOR

(57)Abstract:




PURPOSE: To provide an organic positive temperature coefficient characteristic thermistor which has a steep rise of the PTC characteristics and shows a large resistance change and, further, has little variation of a resistance value.

CONSTITUTION: The organic positive temperature coefficient characteristics thermistor of the present invention is made of the mixture of thermosetting resin and conductive particles having spike-type protrusions and conductive short fibers. As the mixture of the conductive particles having spike-type protrusions facilitates the flow of a tunnel current because of the shapes of the particles and has better conducting properties than the mixture of purely spherical conductive particles, an initial resistance value at a room temperature can be lowered. As the distance between the conductive particles is larger than the distance between spherical conductive particles, the rise of the PTC characteristics is steep and a large resistance change is provided. The variation of the resistance is smaller than that of the mixture of fiber-type conductive particles. By employing both the conductive particles and the conductive short fibers, the conductive short fibers function as bypasses between the conductive particles, so that the total quantity of added conductive material can be reduced.

LEGAL STATUS

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## CLAIMS

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[Claim(s)]
[Claim 1] The organic positive thermistor characterized by coming to mix thermosetting resin, the conductive particle which has the projection of the letter of a spike, and a conductive staple fiber.
[Claim 2] It is the organic positive thermistor according to claim 1 with which said conductive particle makes a content 5 thru/or 50 % of the weight, and said conductive staple fiber makes 5 thru/or 20 micrometers, and die length to 500 micrometers or less, and it makes a content 1 thru/or 10 % of the weight for a diameter.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the organic positive thermistor which has the property, i.e., a PTC (Positive TemperatureCoeffici ent) property, that resistance increases rapidly in the temperature field of the time specification of a temperature up in more detail about an organic positive thermistor.
[0002]
[Description of the Prior Art] Conventionally, the thing which made thermosetting resin, such as an epoxy resin, polyimide, unsaturated polyester, silicon, polyurethane, and phenol resin, distribute fibrous conductive material, such as a carbon fiber, a graphite fiber, graphite lamellar compound fiber, a metal fiber, and ceramic fiber, etc. is known as an organic positive thermistor (for example, U.S. Pat. No. 4966729 specification etc.).
[0003] Although such an organic positive thermistor can be applied to a thermometric element or an autogenous regulation mold heater, the standup of a PTC property presents a steep and big change in resistance, and it needs for the initial resistance in a room temperature to be small moreover.
[0004]
[Problem(s) to be Solved by the Invention] However, in the conventional organic positive thermistor, since the conductive matter distributed by thermosetting resin was fibrous, dispersion in resistance was large and there was a problem that it was difficult to lower initial resistance.
[0005] Then, this invention is made in view of the above-mentioned situation, the initial resistance in a room temperature is small, a steep and big change in resistance is presented and, moreover, the standup of a PTC property aims to let dispersion in resistance offer a small organic positive thermistor.
[0006]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, invention according to claim 1 is an organic positive thermistor characterized by coming to mix thermosetting resin, the conductive particle which has the projection of the letter of a spike, and a conductive staple fiber.
[0007] Moreover, in invention according to claim 2, in invention according to claim 1, a conductive particle makes a content 5 thru/or 50 % of the weight, and a conductive staple fiber makes 5 thru/or 20 micrometers, and die length to 500 micrometers or less, and it makes a content 1 thru/or 10 % of the weight for a diameter.
[0008]
[Function] Since the particle which has the projection of the letter of a spike as a conductive particle mixed with thermosetting resin is used according to invention according to claim 1, since the configuration, therefore tunnel current become easy to flow and conductivity becomes good, the initial resistance in a room temperature becomes small by the conductive particles which have the projection of the letter of a spike compared with the case where a conductive true ball-like particle is mixed. Moreover, since spacing of conductive particles is large compared with a spherical thing, it goes out easily in a point of contact, and the standup of a PTC property presents a steep and big change in resistance. Moreover, compared with the case where a fibrous conductive particle is mixed, dispersion in resistance becomes small. Moreover, by using together a conductive particle and a conductive staple fiber as conductive matter, a conductive staple fiber plays the role of the bypass of conductive particles, and can reduce the addition of the conductive whole matter.
[0009] Furthermore, since thermosetting resin is used as resin mixed with a conductive particle, it is incombustibility, and compared with the case where thermoplastics is used, bridge formation processing becomes unnecessary and the effectiveness which was [ simplify / a production process ] excellent is acquired.

[0010] according to invention according to claim 2 -- the content of a conductive particle -- 5 thru/or 50 % of the weight -- desirable -- 15 -- or 35% of the weight Or it takes preferably for 2 thru/or 6 % of the weight 10% of the weight. the diameter of a conductive staple fiber -- 5 thru/or 20 micrometers, and die length -- 500 micrometers or less and a content -- 1 -- It considers as the particle which has the projection of the letter of a spike as a conductive particle, and said characteristic effectiveness by having used together the conductive particle and the conductive staple fiber as conductive matter becomes more remarkable.
[0011]
[Example] Hereafter, the example of this invention is explained in full detail.
[0012] The organic positive thermistors of one example of this invention are the conductive particle to which it has thermosetting resin as base resin (matrix), and they have the projection of the letter of a spike as a filler, and a thing which similarly comes to mix a conductive staple fiber and a curing agent as a filler.
[0013] As said thermosetting resin, there are an epoxy resin, polyimide, unsaturated polyester, silicon, polyurethane, phenol resin, etc. Thermosetting resin can be suitably chosen according to the desired engine performance, an application, etc., and an epoxy resin (Ciba-Geigy Araldite F) is used for it by this example.
[0014] The mean particle diameter 2.2 thru/or the 2.8 micrometers (it measures by the Fischer subsieve method) filament-like chain-like nickel powder (parakeet company make) with which effectiveness equivalent to nickel powder which has the projection of mean particle diameter 3 thru/or the 7-micrometer letter of a spike as a conductive particle which has the projection of said letter of a spike is acquired is used.
[0015] As said conductive staple fiber, the Toho Rayon diameter 5 thru/or 20 micrometers, and a carbon fiber with a die length of 200 micrometers are used.
[0016] The Ciba-Geigy hardener is used as said curing agent.
[0017] As the 1 manufacture approach of said organic positive thermistor, said each organization of the specified quantity is mixed (vacuum churning degassing), this is slushed between electrodes (for example, nickel foil), press forming is carried out to the shape of a sheet, and a tabular organic positive thermistor is obtained by punching after hardening this (140 degrees C, 1 hour as [ Considering as precure. ] 80 degrees C, 30 minutes, and this hardening).
[0018] Thus, the effectiveness acquired by the constituted organic positive thermistor is explained with reference to Table 1 and drawing 1 , and drawing 2 . Table 1 shows the initial resistance and resistance temperature characteristic in a room temperature of the organic positive thermistor into which the rate of each organization was changed. The thing and drawing 2 to which drawing 1 made the graph the example 1 in Table 1 thru/or 4 make a graph the example 1 of a comparison in Table 1 thru/or 3.
[0019]
[Table 1]

| | 主剤 (アラルダイトF) (wt%) | 硬化剤 (ハードナー) (wt%) | フィラー (Niパウダー) (wt%) | フィラー (短繊維) (wt%) | 初期抵抗値 (Ω) | 抵抗変化率 |
|---|---|---|---|---|---|---|
| 実施例1 | 62.6 | 14.4 | 20.0 | 3.0 | 0.15 | $2\times10^7$ |
| 実施例2 | 74.8 | 17.2 | 5.0 | 3.0 | 1.8 | $1\times10^7$ |
| 実施例3 | 38.2 | 8.8 | 50.0 | 3.0 | 0.02 | $4\times10^5$ |
| 実施例4 | 56.9 | 13.1 | 20.0 | 10.0 | 0.10 | $7\times10^5$ |
| 比較例1 | 30.1 | 6.9 | 60.0 | 3.0 | 0.01 | $3\times10^4$ |
| 比較例2 | 48.8 | 11.2 | 20.0 | 20.0 | 0.08 | $2\times10^3$ |
| 比較例3 | 62.6 | 14.4 | 20.0 | 3.0 | 0.16 | $2\times10^4$ |

An example 1 thru/or 4 and the example 1 of a comparison thru/or the sample of 3 As shown in Table 1, what changed the rate of each tissue of Araldite F, a hardener, nickel powder, and a staple fiber is mixed (vacuum churning degassing). This was slushed between electrodes (nickel foil), press forming was carried out to the shape of a sheet, and what was pierced to disc-like [ with a diameter of 10mm ] was used after hardening this (140 degrees C, 1 hour as [ Considering as precure. ] 80 degrees C, 30 minutes, and this hardening). In addition, the thing with a Toho Rayon die length of 1mm was used for the staple fiber used in the example 2 of a

comparison.
[0020] An example 1 thru/or 4 and the example 1 of a comparison thru/or 3 put in the above-mentioned sampl in the thermostat, and performed a temperature rise and descent, and measurement of a PTC property measure the resistance of whenever [ constant temperature ] everywhere, and asked for the relation between temperatur and resistance.
[0021] (a) Since the particle which has the projection of the letter of a spike as a conductive particle was used, since the configuration, therefore tunnel current became easy to flow and conductivity became good, the initia resistance in a room temperature became small by the conductive particles which have the projection of the letter of a spike compared with the case where a conductive true ball-like particle is mixed. It was set to 0.02 ohms in 1.8 ohms a little high in 0.15 ohms and an example 2 in the example 1, and the example 3, and was se to 0.10 ohms in the example 4. In the example 1 of a comparison, it became 0.01 ohms and a low value with superfluous nickel powder. In the example 2 of a comparison, since conductivity improved when the amount c the conductive whole matter increased, it became 0.08 ohms and a low value. It was set to 0.16 ohms in the example 3 of a comparison. In addition, at less than 5 % of the weight, resistance rose conversely, and the addition of nickel powder brought a result which cannot be used as a thermistor.
[0022] (b) Since spacing of the conductive particles which have the projection of the letter of a spike was larg compared with the spherical thing, it went out easily in the point of contact, and the standup of a PTC property presented the steep and big change in resistance. In the example 1, resistance rises rapidly with transition temperature, and the maximum resistance is 4x108. It is set to omega and resistance rate of change is 2x107. I became the above high value. Resistance rate of change is 4x105 like [ an example 2 thru/or 4 ] an example 1. Or 1x107 It became the high value to say. Since an electric conduction path is not intercepted with superfluou nickel powder in the example 1 of a comparison, resistance rate of change is 3x104. The rapid resistance rise was not seen. Although conductivity improves in the example 2 of a comparison when the amount of the conductive whole matter increases, in order that contact of fiber may still remain conversely at the time of hig temperature, it is 2x103. It seldom changed. At the example 3 of a comparison, the die length of fiber is 2x104 by the ********. Change of resistance became small.
[0023] (c) Since the particle which has the projection of the letter of a spike as a conductive particle is used, compared with the case where a fibrous conductive particle is mixed, dispersion in resistance becomes small. the example 1, there is no fall of resistance also in the temperature of 130 degrees C or more which is the maximum resistance, and the deformation by the heat of a sample is not produced.
[0024] therefore -- for this invention's obtaining the target thermistor -- the content of a conductive particle -- thru/or 50 % of the weight -- desirable -- 15 thru/or 35 % of the weight -- carrying out -- the diameter of a conductive staple fiber -- 5 thru/or 20 micrometers, and die length -- 500 micrometers or less and a content -- - or it is thought that 2 thru/or 6 % of the weight are preferably suitable 10% of the weight.
[0025] (d) By using together a conductive particle and a conductive staple fiber as conductive matter, a conductive staple fiber plays the role of the bypass of conductive particles, and can reduce the addition of the conductive whole matter.
[0026] (e) Since thermosetting resin is used as resin mixed with a conductive particle, it is incombustibility, a in the case of thermoplastics, in order to suppress a NTC phenomenon, the indispensable bridge formation processing becomes unnecessary. Moreover, since sheet-izing of a thermistor and electrode attachment can be performed in one, compared with the case of thermoplastics, the effectiveness which was [ simplify / a production process ] excellent is acquired.
[0027] in addition, this invention is not limited to the above-mentioned example, but within limits which do n change the summary, is boiled variously and can carry out deformation implementation.
[0028]
[Effect of the Invention] Since the particle which has the projection of the letter of a spike as a conductive particle is used according to invention according to claim 1 explained in full detail above, since the configuration, therefore tunnel current become easy to flow and conductivity becomes good, the initial resistance in a room temperature becomes small by the conductive particles which have the projection of the letter of a spike compared with the case where a conductive true ball-like particle is mixed. Moreover, since spacing of conductive particles is large compared with a spherical thing, it goes out easily in a point of contac and the standup of a PTC property presents a steep and big change in resistance. Moreover, compared with th

case where a fibrous conductive particle is mixed, dispersion in resistance becomes small. Moreover, by using together a conductive particle and a conductive staple fiber as conductive matter, a conductive staple fiber plays the role of the bypass of conductive particles, and can reduce the addition of the conductive whole matter. Furthermore, since thermosetting resin is used as resin mixed with a conductive particle, it is incombustibility, and compared with the case where thermoplastics is used, bridge formation processing becomes unnecessary and simplification of a production process etc. can be attained. Therefore, the organic positive thermistor which has the effectiveness which was [ be / moreover / the standup of a PTC property presents a steep and big change in resistance, and / dispersion in resistance / the initial resistance in a room temperature is small, / small ] excellent can be offered.
[0029] According to invention according to claim 2, since 5 thru/or 20 micrometers, and die length are made to 500 micrometers or less and the content is made [ the content of a conductive particle ] into 1 thru/or 10 % of the weight for the diameter of a conductive staple fiber 5 thru/or 50% of the weight, the organic positive thermistor which has the effectiveness which was [ be / moreover / the standup of a PTC property presents a steep and big change in resistance, and / dispersion in resistance / the initial resistance in a room temperature is smaller than invention according to claim 1, / small ] excellent can be offered.

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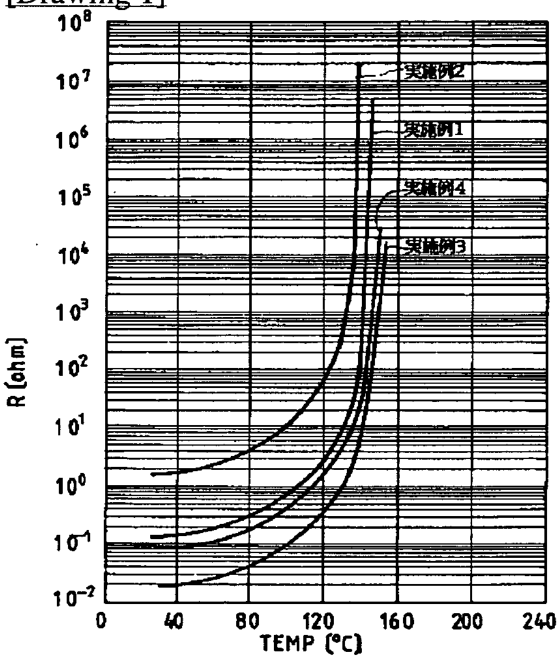
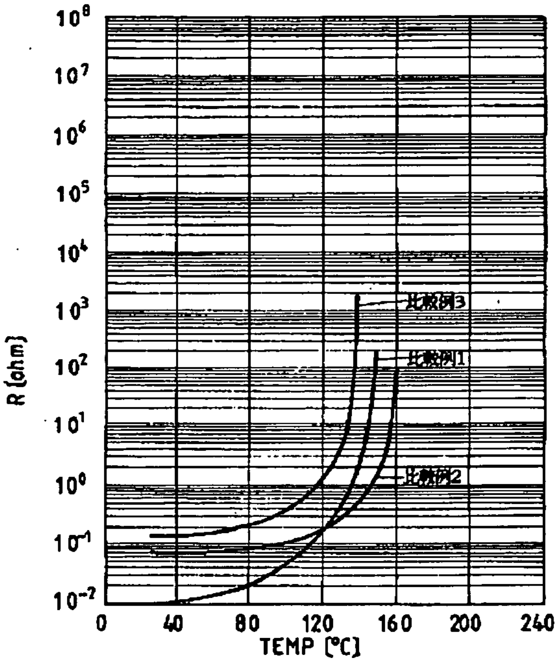
## DRAWINGS

[Drawing 1]




[Drawing 2]

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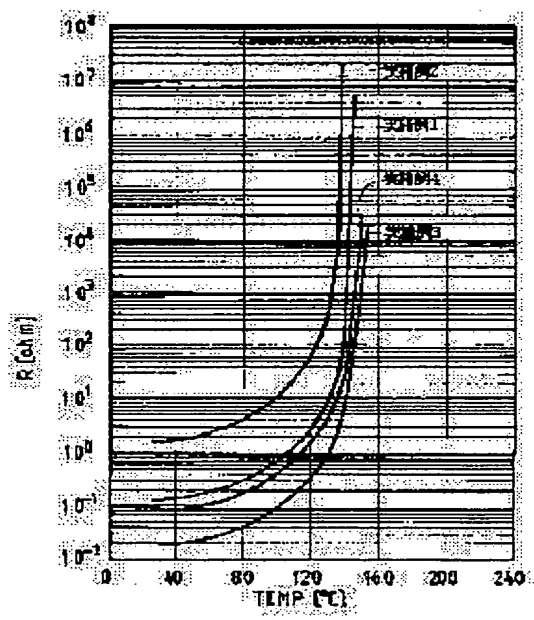
CONSTITUTION: The organic positive temperature coefficient characteristics thermistor of the present invention is made of the mixture of thermosetting resin and conductive particles having spike-type protrusions and conductive short fibers. As the mixture of the conductive particles having spike-type protrusions facilitates the flow of a tunnel current because of the shapes of the particles and has better conducting properties than the mixture of purely spherical conductive particles, an initial resistance value at a room temperature can be lowered. As the distance between the conductive particles is larger than the distance between spherical conductive particles, the rise of the PTC characteristics is steep and a large resistance change is provided. The variation of the resistance is smaller than that of the mixture of fiber-type conductive particles. By employing both the conductive particles and the conductive short fibers, the conductive short fibers function as bypasses between the conductive particles, so that the total quantity of added conductive material can be reduced.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(43)公開日　平成５年(1993)８月６日

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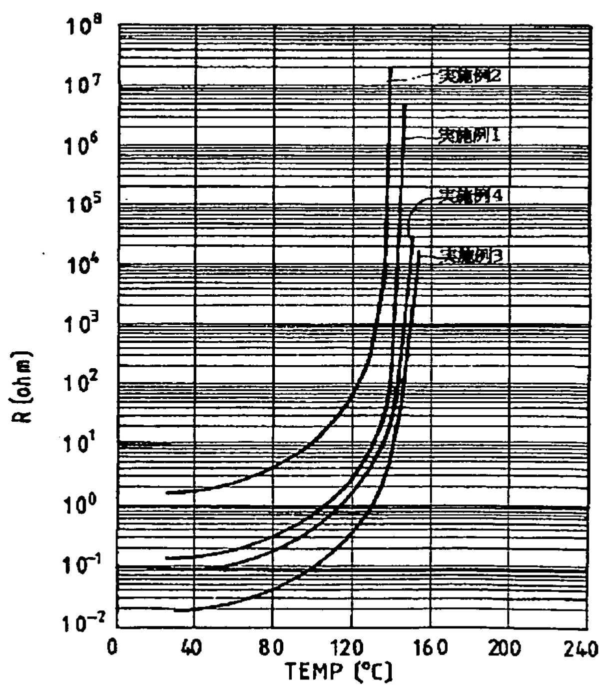
(54)【発明の名称】　有機質正特性サーミスタ

(57)【要約】

【目的】　ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、しかも抵抗値のばらつきが小さい有機質正特性サーミスタを提供する。

【構成】　本有機質正特性サーミスタは、熱硬化性樹脂とスパイク状の突起を有する導電性粒子と導電性短繊維とを混合してなるものである。スパイク状の突起を有する導電性粒子同士では、真球状の導電性粒子を混合した場合に比べ、その形状故にトンネル電流が流れやすくなり、室温での初期抵抗値が小さくなる。導電性粒子同士の間隔が球状のものに比べて大きいので、ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、繊維状の導電性粒子を混合した場合に比べ、抵抗値のばらつきが小さくなる。導電性粒子と導電性短繊維とを併用することにより、導電性短繊維が導電性粒子同士のバイパスの役割を果たし、導電性物質全体の添加量を低減できる。



【特許請求の範囲】

【請求項1】　熱硬化性樹脂とスパイク状の突起を有する導電性粒子と導電性短繊維とを混合してなることを特徴とする有機質正特性サーミスタ。

【請求項2】　前記導電性粒子は含有量を５乃至５０重量％とし、前記導電性短繊維は直径を５乃至２０μm，長さを５００μm以下，含有量を１乃至１０重量％とする請求項１記載の有機質正特性サーミスタ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、有機質正特性サーミスタに関し、より詳しくは、昇温時特定の温度領域で急激に抵抗値が増大する特性、すなわち、ＰＴＣ（Positive TemperatureCoefficient）特性を有する有機質正特性サーミスタに関する。

【０００２】

【従来の技術】従来、有機質正特性サーミスタとして、エポキシ樹脂，ポリイミド，不飽和ポリエステル，シリコン，ポリウレタン及びフェノール樹脂等の熱硬化性樹脂に、炭素繊維，黒鉛繊維，黒鉛層間化合物繊維，金属繊維及びセラミック繊維等の繊維状導電物質等を分散させたものが知られている（例えば、米国特許第４９６６７２９号明細書等）。

【０００３】このような有機質正特性サーミスタは、例えば温度検出器又は自己制御型ヒーター等に適用し得るが、ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、しかも室温での初期抵抗値が小さいことが必要である。

【０００４】

【発明が解決しようとする課題】しかし、従来の有機質正特性サーミスタにおいては、熱硬化性樹脂に分散された導電性物質が繊維状であるため、抵抗値のばらつきが大きく、また、初期抵抗値を下げることが難しいという問題があった。

【０００５】そこで、本発明は、上記事情に鑑みてなされたものであり、室温での初期抵抗値が小さく、ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、しかも抵抗値のばらつきが小さい有機質正特性サーミスタを提供することを目的とする。

【０００６】

【課題を解決するための手段】上記目的を達成するために請求項１記載の発明は、熱硬化性樹脂とスパイク状の突起を有する導電性粒子と導電性短繊維とを混合してなることを特徴とする有機質正特性サーミスタである。

【０００７】また、請求項２記載の発明は、請求項１記載の発明において、導電性粒子は含有量を５乃至５０重量％とし、導電性短繊維は直径を５乃至２０μm，長さを５００μm以下，含有量を１乃至１０重量％とするものである。

【０００８】

【作用】請求項１記載の発明によれば、熱硬化性樹脂と混合する導電性粒子としてスパイク状の突起を有する粒子を用いているので、真球状の導電性粒子を混合した場合に比べ、スパイク状の突起を有する導電性粒子同士では、その形状故にトンネル電流が流れやすくなって、導電性が良好となるため、室温での初期抵抗値が小さくなる。また、導電性粒子同士の間隔が球状のものに比べて大きいので、接触点で容易に切れてＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈する。また、繊維状の導電性粒子を混合した場合に比べ、抵抗値のばらつきが小さくなる。また、導電性物質として導電性粒子と導電性短繊維とを併用することにより、導電性短繊維が導電性粒子同士のバイパスの役割を果たし、導電性物質全体の添加量を低減できる。

【０００９】さらに、導電性粒子と混合する樹脂として熱硬化性樹脂を用いているので、不燃性であり、熱可塑性樹脂を用いた場合に比べ、架橋処理が不要となり、製造工程を簡略化できる等の優れた効果が得られる。

【００１０】請求項２記載の発明によれば、導電性粒子の含有量を５乃至５０重量％好ましくは１５乃至３５重量％、導電性短繊維の直径を５乃至２０μm，長さを５００μm以下，含有量を１乃至１０重量％好ましくは２乃至６重量％とし、導電性粒子としてスパイク状の突起を有する粒子とし、導電性物質として導電性粒子と導電性短繊維とを併用したことによる前記特有の効果がより顕著となる。

【００１１】

【実施例】以下、本発明の実施例を詳述する。

【００１２】本発明の一実施例の有機質正特性サーミスタは、主剤（マトリックス）として熱硬化性樹脂，フィラーとしてスパイク状の突起を有する導電性粒子，同じくフィラーとして導電性短繊維及び硬化剤を混合してなるものである。

【００１３】前記熱硬化性樹脂としては、エポキシ樹脂，ポリイミド，不飽和ポリエステル，シリコン，ポリウレタン及びフェノール樹脂等がある。熱硬化性樹脂は、所望の性能，用途等に応じて適宜選択することができ、本実施例では、エポキシ樹脂（チバガイギー製のアラルダイトＦ）を用いる。

【００１４】前記スパイク状の突起を有する導電性粒子としては、平均粒径３乃至７μmのスパイク状の突起を有するＮｉパウダーと同等の効果が得られる平均粒径２．２乃至２．８μm（フィッシャー・サブシーブ法で測定）のフィラメント状鎖状Ｎｉパウダー（インコ社製）を用いる。

【００１５】前記導電性短繊維としては、東邦レーヨン製の直径５乃至２０μm，長さ２００μmの炭素繊維を用いる。

【００１６】前記硬化剤としては、チバガイギー製のハードナーを用いる。

【００１７】前記有機質正特性サーミスタの一製造方法としては、所定量の前記各組織を混合（真空攪拌脱泡）し、これを電極（例えばＮｉ箔）間に流し込んでシート状にプレス成形し、これを硬化（予備硬化として８０℃，３０分、本硬化として１４０℃，１時間）後、パンチングにより板状の有機質正特性サーミスタを得る。

【００１８】このように構成された有機質正特性サーミスタにより得られる効果を、表１及び図１，図２を参照して説明する。表１は各組織の割合いを変えた有機質正特性サーミスタの室温での初期抵抗値及び抵抗温度特性を示すものである。図１は表１における実施例１乃至４をグラフにしたもの、図２は表１における比較例１乃至３をグラフにしたものである。

【００１９】

【表１】

| | 主　剤 (ｱﾗﾙﾀﾞｲﾄF) (wt%) | 硬化剤 (ﾊｰﾄﾞﾅｰ) (wt%) | フィラー (Niﾊﾟｳﾀﾞｰ) (wt%) | フィラー (短繊維) (wt%) | 初　期 抵抗値 (Ω) | 抵　抗 変化率 |
|---|---|---|---|---|---|---|
| 実施例１ | 62.6 | 14.4 | 20.0 | 3.0 | 0.15 | $2\times10^7$ |
| 実施例２ | 74.8 | 17.2 | 5.0 | 3.0 | 1.8 | $1\times10^7$ |
| 実施例３ | 38.2 | 8.8 | 50.0 | 3.0 | 0.02 | $4\times10^5$ |
| 実施例４ | 56.9 | 13.1 | 20.0 | 10.0 | 0.10 | $7\times10^5$ |
| 比較例１ | 30.1 | 6.9 | 60.0 | 3.0 | 0.01 | $3\times10^4$ |
| 比較例２ | 48.8 | 11.2 | 20.0 | 20.0 | 0.08 | $2\times10^3$ |
| 比較例３ | 62.6 | 14.4 | 20.0 | 3.0 | 0.16 | $2\times10^4$ |

実施例１乃至４及び比較例１乃至３のサンプルは、表１に示すように、アラルダイトＦ，ハードナー，Ｎｉパウダー，短繊維の各組織の割合いを変えたものを混合（真空攪拌脱泡）し、これを電極（Ｎｉ箔）間に流し込んでシート状にプレス成形し、これを硬化（予備硬化として８０℃，３０分、本硬化として１４０℃，１時間）後、直径１０ｍｍの円板状に打ち抜いたものを用いた。なお、比較例２で用いた短繊維は、東邦レーヨン製の長さ１ｍｍのものを用いた。

【００２０】ＰＴＣ特性の測定は、実施例１乃至４及び比較例１乃至３ともに、上記サンプルを恒温槽内に入れ、温度上昇及び下降を行い、各所定温度における抵抗値を測定し、温度と抵抗値との関係を求めた。

【００２１】(a) 導電性粒子としてスパイク状の突起を有する粒子を用いているので、真球状の導電性粒子を混合した場合に比べ、スパイク状の突起を有する導電性粒子同士では、その形状故にトンネル電流が流れやすくなって、導電性が良好となるため、室温での初期抵抗値が小さくなった。実施例１では０．１５Ω、実施例２ではやや高い１．８Ω、実施例３では０．０２Ω、実施例４では０．１０Ωとなった。比較例１では、過剰なＮｉパウダーにより０．０１Ωと低い値となった。比較例２では、導電性物質の全体量が増えることにより導電性が向上したため０．０８Ωと低い値となった。比較例３では０．１６Ωとなった。なお、Ｎｉパウダーの添加量が５重量％未満では、抵抗値が逆に上昇してしまい、サーミスタとして使用できない結果となった。

【００２２】(b) スパイク状の突起を有する導電性粒子同士の間隔が球状のものに比べて大きいので、接触点で容易に切れてＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈した。実施例１では、転移温度では抵抗値が急激に上昇して最大抵抗値は $4\times10^8$ Ωになり、抵抗変化率は $2\times10^7$ 以上の高い値となった。実施例２乃至４では、実施例１と同様に抵抗変化率は $4\times10^5$ 乃至 $1\times10^7$ という高い値となった。比較例１では、過剰なＮｉパウダーにより導電経路が遮断されないため抵抗変化率は、$3\times10^4$ と急激な抵抗上昇は見られなかった。比較例２では、導電性物質の全体量が増えることにより導電性が向上するが、高温度時においては逆に繊維同士の接触が依然として残るため、$2\times10^3$ とあまり変化しなかった。比較例３では、繊維の長さが長いことにより、$2\times10^4$ と抵抗の変化が小さくなった。

【００２３】(c) 導電性粒子としてスパイク状の突起を有する粒子を用いているので、繊維状の導電性粒子を混合した場合に比べ、抵抗値のばらつきが小さくなる。実施例１では、最大抵抗値である１３０℃以上の温度においても抵抗値の低下はなく、サンプルの熱による変形は生じていない。

【００２４】従って、本発明が目的としているサーミスタを得るには、導電性粒子の含有量を５乃至５０重量％好ましくは１５乃至３５重量％とし、導電性短繊維の直径を５乃至２０μｍ，長さを５００μｍ以下，含有量を１乃至１０重量％好ましくは２乃至６重量％が適していると思われる。

【００２５】(d) 導電性物質として導電性粒子と導電性短繊維とを併用することにより、導電性短繊維が導電性粒子同士のバイパスの役割を果たし、導電性物質全体の添加量を低減できる。

【００２６】(e) 導電性粒子と混合する樹脂として熱硬化性樹脂を用いているので、不燃性であり、熱可塑性樹

脂の場合ではＮＴＣ現象を抑えるために必要不可欠であった架橋処理が不要となる。また、サーミスタのシート化及び電極付けを一体的に行えるので、熱可塑性樹脂の場合に比べ、製造工程を簡略化できる等の優れた効果が得られる。

【００２７】なお、本発明は上記実施例に限定されず、その要旨を変更しない範囲内で種々に変形実施できる。

【００２８】

【発明の効果】以上詳述した請求項１記載の発明によれば、導電性粒子としてスパイク状の突起を有する粒子を用いているので、真球状の導電性粒子を混合した場合に比べ、スパイク状の突起を有する導電性粒子同士では、その形状故にトンネル電流が流れやすくなって、導電性が良好となるため、室温での初期抵抗値が小さくなる。また、導電性粒子同士の間隔が球状のものに比べて大きいので、接触点で容易に切れてＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈する。また、繊維状の導電性粒子を混合した場合に比べ、抵抗値のばらつきが小さくなる。また、導電性物質として導電性粒子と導電性短繊維とを併用することにより、導電性短繊維が導電性粒子同士のバイパスの役割を果たし、導電性物質全体の添加量を低減できる。さらに、導電性粒子と混合する樹脂として熱硬化性樹脂を用いているので、不燃性であり、熱可塑性樹脂を用いた場合に比べ、架橋処理が不要となり、製造工程の簡略化等が図れる。従って、室温での初期抵抗値が小さく、ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、しかも抵抗値のばらつきが小さい等の優れた効果を有する有機質正特性サーミスタを提供することができる。

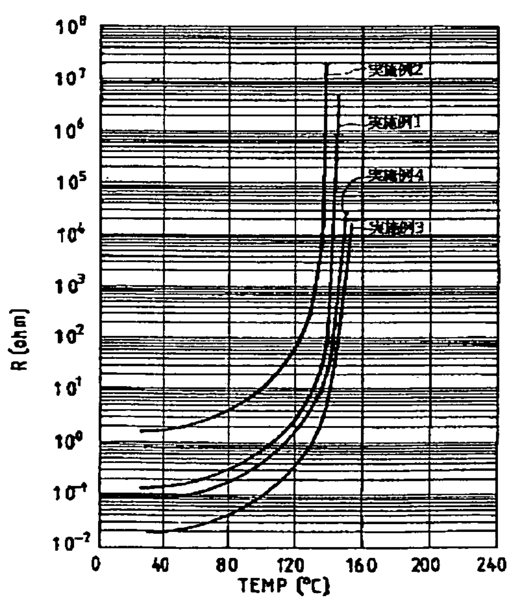
【００２９】請求項２記載の発明によれば、導電性粒子の含有量を５乃至５０重量％、導電性短繊維の直径を５乃至２０μｍ，長さを５００μｍ以下，含有量を１乃至１０重量％としているので、請求項１記載の発明よりも室温での初期抵抗値が小さく、ＰＴＣ特性の立ち上がりが急峻で大きな抵抗値変化を呈し、しかも抵抗値のばらつきが小さい等の優れた効果を有する有機質正特性サーミスタを提供することができる。

【図面の簡単な説明】

【図１】本発明の有機質正特性サーミスタの実施例１乃至４の抵抗温度特性を示すグラフである。

【図２】有機質正特性サーミスタの比較例１乃至３の抵抗温度特性を示すグラフである。

【図１】




【図２】